NAVSEA
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# PERFORMANCE SPECIFICATION
## Low Pressure Air Plant
## Non-Lubricated, Rotary Unit


Prepared by: Dawn E. Ware
Dawn E. Ware
Program Manager

Approved by: J. Jeffrey Craighead
J. Jeffrey Craighead, P.E.
Head, Compressed Air Systems Engineering Section
Carderock Division
Naval Surface Warfare Center, Code 9214



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Attachment (I)

# PURCHASE SPECIFICATION
# LOW PRESSURE AIR PLANT
# FOR SHIP SERVICE AIR APPLICATIONS

## 1. SCOPE

### 1.1. EQUIPMENT

This specification establishes the performance, design parameters, instrumentation, qualification testing, manufacturing and acceptance requirements for the Low Pressure Air Plant for Ship Service Air Applications. The Low Pressure Air Plant is comprised of a Low Pressure Air Compressor and a Low Pressure Air Membrane Dehydrator. All assemblies, sub-assemblies and components, identified herein or required for proper operation of the equipment, shall be furnished by the Seller. The word "plant" denotes the entire complex of equipment throughout this specification.

### 1.2. CLASSIFICATION

Low pressure air plants intended for use on Surface Ships, shall be classified as follows:

**Class III** - Rated capacity of 300 scfm, minimum, with 0°F dewpoint discharge air quality ( at 125 psig discharge air pressure and 75 degree F sea water inlet temperature)

Note: Navy standard conditions for capacity measurements are 68 degrees Fahrenheit, 14.7 psia, and 36% relative humidity

## 2. APPLICABLE DOCUMENTS.

### 2.1. GENERAL

The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

### 2.2. GOVERNMENT DOCUMENTS.

#### 2.2.1. SPECIFICATIONS AND STANDARDS.

The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation

**FEDERAL SPECIFICATIONS**

| | | |
|---|---|---|
| TT-P-645B | 12 MAR 1990 | Primer, Paint, Zinc-Molybdate, Alkyd Type. |

**DEPARTMENT OF DEFENSE SPECIFICATIONS**

| | | |
|---|---|---|
| MIL-S-901D | 17 MAR 1989 | Shock Tests, High Impact, Shipboard Machinery, Equipment and Systems, Requirements for. |
| MIL-G-18997E(1) | 1 JUN 1995 | Gauge, pressure, dial indicating. |
| MIL-V-24578B | 27 MAY 1988 | Valves, Globe, Pressure Instruments, Stem Test Connection, Union end. |
| MIL-M-17060F | 25 MAY 1995 | Motors, 60 Hertz, AC, Shipboard use. |
| MIL-F-1183J | 05 May 87 | Fitting, pipe, cast bronze, silver brazing, General Spec for |

**DEPARTMENT OF DEFENSE STANDARDS**

| | | |
|---|---|---|
| MIL-STD-167/1 | 1 MAY 1974 | Mechanical Vibrations of shipboard Equipment (Type I – Environmental) |
| MIL-STD-740/1 | 30 DEC 1986 | Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment. |
| MIL-STD-740/2 | 30 DEC 1986 | Structureborne Vibratory Acceleration Measurements, Acceptance Criteria of Shipboard Equipment. |
| MIL-STD-777E(3) | 1 JUN 1995 | Schedule of Piping, Valves, Fittings and Associated Piping Components for Naval Surface Ships. |
| MIL-STD-882D | 10 Feb 2000 | System Engineering |
| MIL-STD-461E | 20 August 1999 | Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment. |
| Mil-STD-1399C/300 | 2 FEB 1988 | Interface Standard for Shipboard Systems. !!Metric!! |
| MIL-STD-1472F | 23 Aug 99 | Human Engineering |

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Automated Printing Service (DAPS), 700 Robbins Avenue, Philadelphia, PA 19111-5098, 215/697-2179. The above specifications are also available through the website www.dsp.dal.mil)

**2.2.2. OTHER GOVERNMENT DOCUMENTS, DRAWINGS, AND PUBLICATIONS.**

Drawing, NAVSEA Standard

| | |
|---|---|
| 810-1385850 Rev. G | Piping, Instrument, Pressure for all Service |

(Copies of the above drawing are available from Commander, Portsmouth Naval Shipyard, Code 280.6, Portsmouth, NH 03804-5000, 207/438-2445)

Publication, NAVSEA Technical

S9074-AR-GIB-010/278 1 Aug 95 Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, piping and Pressure Vessels

(Copies of the above publication are available from Naval Inventory Control Point, Code 1, Support Branch (Cash Sales), 700 Robbins Avenue, Philadelphia, PA 19111-5094, 215/697-2626)

**2.3. NON-GOVERNMENT PUBLICATIONS.**

The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents, which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of the documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

**INDUSTRY STANDARDS**

ISO 8573-1:1991(E) Compressed Air for General Use – Part 1: Contaminants and quality classes

National Electrical Manufacturers Association (NEMA)

NEMA MG1 – Motors and Generators.

Institute of Electrical and Electronic Engineers (IEEE)

IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors.

American Bearing Manufacturers Association (ABMA)

ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

American National Standards Institute (ANSI)

ANSI B1 – Thread standards.

ANSI/USPRO/IPO 100-1993 – IGES Graphics format, Requirements for

American Society of Mechanical Engineers (ASME)

ASME Y14.100M – Engineering Drawing practices

ASME PTD 9 – Displacement compressors Power Test Code.

Steel Structures Painting Council
SSPC Paint NO. 21

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using federal agencies.)

**2.4. ORDER OF PRECEDENCE.**

In the event of a conflict between the text of this document and the references cited herein (except for related associated specifications or specification sheets), the text of this document takes precedence. Nothing in this document, however, supercedes applicable laws and regulations unless a specific exemption has been obtained.

**3. REQUIREMENTS.**

**3.1. GENERAL DESCRIPTION.**

The low pressure air plant shall be comprised of a low pressure air compressor and a low pressure air dehydrator.

**3.1.1.**

The low pressure air compressor shall be an oil-free, air rotary design, using seawater to cool. The operation of the compressor shall be fully automatic, and controlled by a Programmable Logic Controller. The specific requirements are cited in the confines of this document.

**3.1.2.**

The low pressure air dehydrator shall consist of a coalescing filter with automatic and manual drain devices, filter differential pressure gage(s), membrane dryer module(s), inlet and outlet flowmeters, outlet pressure gage, and an effluent air sample port. The dehydrator shall be fully automatic and capable of meeting performance requirements with effluent flows from zero to rated flow without requiring operator attention, shall require no electrical power, and shall have no moving parts except for the automatic condensate discharge devices.

## 3.2. FUNCTIONAL PERFORMANCE.

### 3.2.1.

The plant shall produce clean, dry low pressure compressed air as specified herein. Each plant shall operate continuously or intermittently under any combination of the design data listed below. All air coolers must utilize shipboard seawater at the conditions set below.

### 3.2.2. DESIGN DATA

| | |
|---|---|
| Classification | Ship Service Air Applications |
| Capacity | Rated influent flow varies depending upon classification (see 1.2.1). |
| Design Pressure | Design pressure shall be 125 psig. |
| Proof pressure | Air flow path shall withstand a pressure 1.5 times the design pressure. |
| Duty | Continuous and intermittent operation. |

### 3.2.3. ELECTRICAL POWER.

Electrical power supply for the compressor motor will be 440 volt, 3-phase, 60 cycle alternating current (AC) with a maximum voltage variation of plus 10%, minus 20%, of rated voltage at 122°F. Controls shall be operated from 115 volt power or less which shall be supplied by means of a voltage reducing transformer. The goal for the operating amperage is less than 200 Amps.

### 3.2.4. AMBIENT TEMPERATURE.

The plant shall meet all the performance requirements specified at any ambient temperature within the range of 40°F to 122°F and 50% relative humidity.

### 3.2.5. ENVIRONMENTAL STRESS.

#### 3.2.5.1. SHOCK.

The plant shall withstand high impact shock for MIL-S-901D Grade A, Class I, Type A equipment.

#### 3.2.5.2. VIBRATION.

The plant shall meet the vibration requirements for Externally excited vibration, Airborne Noise and Structure borne vibration.

##### 3.2.5.2.1. EXTERNALLY EXCITED VIBRATION.

The plant shall meet the requirements of MIL-STD-167/1 type I, up to 25 hertz.

##### 3.2.5.2.2. AIRBORNE NOISE.

The compressor shall meet the requirements of MIL-STD-740-1, Category D.

##### 3.2.5.2.3. STRUCTURE BORNE VIBRATION.

When specified in the contract or purchase order (Combat ships only) the plant shall meet the structure borne vibration requirements shown in the table above and/or the specific Ship Class requirements given . The vibration shall be measured at the mounting feet in accordance with MIL-STD-740-2.

#### 3.2.5.3. EMI / EMC

The plant shall meet the requirements of MIL-STD 461E, susceptibility test CE101, CE102, CS 101, CS 114, CS115, CS116, RE 101, RE102, RS101 and RS 103.

### 3.2.6. PERFORMANCE PARAMETERS.

The plant shall operate continuously under any combination of the range of operating conditions shown below.

| | |
|---|---|
| Inlet Air Pressure Range | 14.0 - 15.0 psia |
| Inlet Air Temperature | Range 40 - 122 °F |
| Discharge Air Pressure | 125 psig |
| Inlet Air Relative Humidity | Up to 50% R.H. @ 122 °F |
| Maximum Seawater Supply Temperature | 100 °F |
| Seawater Supply Pressure Range | 30-175 psig |
| Maximum Air Discharge Temperature | 122°F |
| Maximum Effluent Air Dewpoint | See Table I |

Table I – Maximum Effluent Air Dewpoints at various operating Conditions

| Effluent Air Dewpoint (maximum) | Discharge Air Pressure | Seawater Supply Temp |
|---|---|---|
| +37°F at pressure | 115 psig | 100°F |
| 0°F at pressure | 125 psig | 75°F |
| | | |

### 3.2.7. INCLINED OPERATION.

The plant shall operate satisfactorily when subjected to the ship motions specified below, regardless of whether the bed plate is installed in the fore and aft or athwart ships position.

- Permanent inclination in any direction 15 degrees
- Vertical roll for up to 8 second 15 degrees
- Horizontal pitch for up to 6 seconds 10 degrees

### 3.2.8. LAY-UP RECOVERY TIME.

After lay-up periods, the effluent moisture content shall recover to maximum allowable levels specified in Table 1 or dryer within 1 hour after start up.

### 3.2.9. RELIABILITY/ MAINTANABILITY

The scheduled general overhaul periodicity goal shall be 30,000 hours for all wear parts excluding filters. An general overhaul is defined as the complete teardown of the air end of the compressor, with measurements and/or replacements of all wear parts, (including a total air end change out). A general overhaul also includes motor rework. The goal for the MTBF of the air end components is 30,000 hours. The mean time between failures (MTBF) of the plant shall be not less than 5,000 hours. A failure shall be any condition or malfunction that requires the plant to be taken off the line for corrective maintenance, or effluent air that does not meet the requirements as specified herein.

### 3.2.9.1. PREVENTIVE MAINTENANCE.

The mean preventive maintenance time shall be not greater than 2 man-hours per month. The time required to perform any preventive maintenance action shall be not greater than 1 man-hour by a machinist mate third class with no formal equipment training.

### 3.2.9.2. MAINTAINABILITY

The dryer module shall require no special tools or skills (i.e. welding or brazing) for installation or replacement. The coalescing filter unit shall be constructed such that for each filter, a machinist mate third class can change the filter element unassisted in 30 minutes or less using only common hand tools.

### 3.2.9.3. CORRECTIVE MAINTENANCE.

The maximum time to perform any corrective maintenance action shall be not greater than 3 man-hours.

## 3.3. ARRANGEMENT AND ACCESSIBILITY.

### 3.3.1.

The plant shall consist of a low pressure compressor and a low pressure dryer module, which are together referred to as a low pressure air plant. The compressor and dryer are not required to be contained on the same skid. An enclosure is only permitted to allow plant to meet MIL-STD-740-1 category D, however, no enclosure is preferred. Piping, instruments, and other components shall be arranged such that their disassembly or removal is not required to provide ready access to components requiring preventive maintenance. Test points, test connections and calibration connections in the plant shall permit easy accessibility without requiring removal or relocation of any components. Instrument panels shall be mounted so as not to interfere with the accessibility requirements of this paragraph. The panel shall be constructed with easy access for daily operations. Instruments shall be visible from the front of the unit.

### 3.3.2. HATCHABILITY.

The plant shall be of modular design and construction to facilitate disassembly and reassembly during shipboard installation. When disassembled, each part shall capable of fitting through a hatch measuring 41" X 38". Disassembly and reassembly of the plant shall require no hotwork such as welding nor grinding.

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### 3.3.3. SAFETY.

The plant shall be designed so that all procedures for installing, operating, inspecting, maintaining, and adjusting the plant can be accomplished in a safe manner. Protection for operating and maintenance personnel against hazards and accidents shall be provided in accordance with Mil-STD-882.

## 3.4. OVERALL WEIGHTS AND DIMENSIONS

### 3.4.1. WEIGHT REQUIRMENTS.

The goal for the overall weight of the low pressure air package is 6000 lbs.

### 3.4.2. SIZE REQUIREMENTS:

The goal for the overall size of the low pressure air plant is 120 x 60 x 70 inches.

## 3.5. MATERIAL.

### 3.5.1. MATERIAL SELECTION.

Materials used in the plant shall meet the requirements specified herein. Where no specific requirements are identified, materials used in the plant shall be corrosion-resistant in a marine environment. Parts in contact with each other shall be selected based on best resistance to galvanic corrosion, galling, seizing, and excessive wear. All materials used in the construction of the plant shall be similarly selected on the basis of corrosion-resistance and anti-galling properties.

### 3.5.2. RECOVERED MATERIAL.

Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials, which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification.

### 3.5.3. PROHIBITED MATERIALS.

The use of toxic chemicals, hazardous substances, or ozone depleting gasses shall not be used wherever feasible. Material used in the construction of the compressor (components and supply support items) shall conform to existing Navy policy on prohibited material. The offered compressor shall be free of asbestos, Polychlorinated Biphenyl (PCB), Mercury, Aluminum fasteners, and Aluminum couplings.

### 3.5.4. FIRE HAZARDOUS MATERIAL.

Material which, when exposed to flames, releases gas or other substance with toxic potency shall not be used in the construction of the compressor.

## 3.6. CONSTRUCTION.

### 3.6.1. PIPING.

Piping/tubing joints and terminals shall use a face type O ring seal, gasket, or equivalent. O rings used in the air piping shall be made of fluorocarbon material per MIL-S-83248/2, . Flexible hose connections are acceptable. Threads will not be used to provide sealing. The use of flared or "bite" type fittings are not permitted. Corrosion resistant materials (either 70/30 CuNi or stainless steel Grade 304 SS) shall be used in all piping in air and water systems.. Piping and fittings shall be corrosion resistant and suitable for installation in a marine environment. Painted, or coated, carbon steel pipe and fittings shall not be used.

### 3.6.2. FITTINGS.

Fittings within the assembly shall be in accordance with MIL-STD-777, unless otherwise specified. Sil-brazed fittings shall not be used. Pipe thread connections and bite-type fittings shall not be used.

### 3.6.3. VALVES.

#### 3.6.3.1.

Each stage of compression, if applicable, shall employ an air relief valve.

### 3.6.4. FLEXIBLE HOSES.

Flexible hoses are permitted, however, no rubber hoses are permitted. All hoses must be wire braided. Hose material must be chosen to withstand operating pressure and temperatures of flow medium.

### 3.6.5. THREADS.

Threads shall conform to MIL-STD-777E. Where necessary, provisions shall be incorporated to prevent the accidental loosening of threaded parts. Components with pipe threads are prohibited. Welding, brazing, or otherwise altering a fitting which has pipe threads to render it impossible to take down shall also be prohibited. Self-tapping screws with machine-screw threads may be used in the cabinet assembly (if applicable). Sheet-metal screws with sheet-metal threads shall not be used.

### 3.6.6. FASTENERS.

Threaded fasteners shall conform to ANSI B1 and shall be through bolts, through studs, bottoming studs, or cap screws in that order of preference. Bottoming studs shall be Class 3 fit with locking resin. No bronze black -oxide coated fasteners are allowed. If metric fasteners are used, a tool box with all necessary tools will be included with the plant. The tool box shall include a metric torque wrench, all necessary special tools, and all metric wrenches needed for an overhaul of the plant.

### 3.6.7. DRAIN AND VENT VALVES.

A valve for oil sampling, if applicable, shall be included on the compressor with a cap and chain on the end of the pipe. The sampling point must originate in the sump All cooling and lubrication systems shall have a method of draining the system for maintenance.

### 3.6.8. PAINTING.

Surfaces to be painted shall be thoroughly cleaned and free from oil, grease, mill scale, rust and loose weld beads. External non-working ferrous and aluminum surfaces shall be painted with one coat of zinc molybdate primer in accordance with TT-P-645B and two coats of silicon alkyd enamel haze-gray paint in accordance with SSPC Paint No. 21 or equivalent. If a different paint is to be used, it must be approved by NSWCCD Code 9214, Phila PA. 19112.

### 3.6.9. WELDING.

Welding and allied processes shall be in accordance with S9074-AR-GIB-010/278. Assembly by brazing of piping, fittings, and valves is prohibited.

### 3.6.10. MOTOR.

The motor used shall meet the following requirements.

Service – Heavy duty, high impact, shock resistant, marine service.

Enclosure – Type I Drip proof protected to 45 degrees inclination.

Sealed Insulation – The winding insulation to be sealed per NEMA MG1.

Efficiency – Design B with efficiency per NEMA MG1 for "energy efficient motors".

Insulation – Class F.

Temperature rise: Winding – Class B, by resistance, at rated horsepower.
Bearings – Rise to allow total bearing temperature, measured on outer ring, not to exceed 90 degrees centigrade in 50 degrees centigrade ambient temperature, at rated load.

Service Factor – 1.15

Maximum ambient temperature – 122°F

Starting method – Across the line, full voltage.

Bearing B10 life – 10,000 hours per ABMA 9 without use of life extension factors.

Bearing radial clearance – C3 radial internal clearance.

Construction- Motor frame, feet, end brackets, bearing caps, fan shrouds, and air deflectors shall be nodular iron and be treated for corrosion resistance.

Fasteners – Fasteners shall be corrosion resistant.

Fans – Fans shall be nodular iron , aluminum, or composite. Fans shall be treated for corrosion resistance, if applicable.

Drawing – Outline drawing to include rewind and bearing replacement information.

Voltage – 440 Vrms
Number Of Phases- 3 phases3
Frequency- 60 Hz.

### 3.6.11. HEAT EXCHANGERS.

The heat exchangers shall be plate or shell and tube type. Heat exchanger tube bundles or plates, which contact seawater, shall be made of titanium or 70/30 CuNi material and selected based on performance efficiency and ease of maintenance. The shell of the heat exchanger shall also be 70/30 cun/Ni or Titanium. Tee connections shall be installed at the sea water inlet and outlet for backflush or chemical cleaning of the heat exchanger The minimum sea water flow velocity through the plate type heat exchanger shall be no less than 2ft/sec. The heat exchanger shall be protected from galvanic corrosion where dissimilar materials are used. Seawater connections shall IAW ANSI Flanges.

#### 3.6.11.1. COMPRESSOR COOLING MEDIUM.

All heat exchanger shall utilize seawater as the cooling medium in accordance with operating conditions in 3.7.3

#### 3.6.11.2. RELIEF VALVES.

All air heat exchangers shall be protected against over-pressurization by relief valves.

### 3.6.12. FILTRATION.

#### 3.6.12.1. FILTER ELEMENTS.

A coalescing filter and a charcoal filter shall be installed at the inlet to the membrane cartridge(s). The coalescing filter shall be a replaceable element type with associated automatic condensate discharge device and drain line. The filter shall also have a manual drain valve to permit blow down of the filter housing. The coalescing filter cartridge shall remove 100 percent of 0.01-micron and larger diameter solid and liquid particles. There shall also be an activated carbon filter after the coalescing filter which passes 0.003 mg/cubic meter maximum of oil. A particulate filter and/or moisture separator shall be installed upstream of the coalescing filter to prevent the need for frequent change-out of the coalescing filter element. Maximum filter pressure drop (from clean to change out) shall not adversely affect the dehydrator pressure drop. Filter elements shall withstand a pressure differential of 75 PSID without deformation or damage. Filter elements, filter attachments and mountings, bowls and bowl closures, seals, seal mountings and seal interface surfaces shall be such that they can be assembled only in the correct manner. Filter elements shall be attached to the filter with a positive mounting, such as a threaded fastener.

#### 3.6.12.2. CONDENSATE DISCHARGE DEVICES.

##### 3.6.12.2.1. DRAINS.

All drain lines shall terminate at a common open funnel drain. The funnel shall be visible from the front of the LPAP for verification of individual drain operation. The common drain shall terminate at the perimeter of the LPAP with a union in accordance with MIL-STD-777E. The drain funnel must be designed such when draining occurs, no water is sprayed out the top of the funnel.

### 3.6.13. INTERCHANGEABILITY.

Unless parts are reversible with regard to function, performance and strength, the parts shall be constructed to insure proper orientation during installation or shall be clearly labeled, such as flow direction or inlet and outlet piping connections.

### 3.6.14. MEMBRANE DRYER MODULE.

All membrane dryer modules used shall have the following salient characteristics.

#### 3.6.14.1. OXYGEN DEPLETION.

Membrane dryer modules which reduce the oxygen content of the effluent air below 19.5% under any operating conditions shall be clearly labeled with a warning to prevent effluent air from being used in a breathing air application.

#### 3.6.14.2. DURABILITY.

The membrane module shall not experience permanent damage when internally or externally exposed to liquid moisture. When exposed to liquid moisture, the module performance shall return to specified parameters after removal of the liquid and drying out period not to exceed 8 hours.

#### 3.6.14.3. RELIABILITY.

The module shall have a 50,000 hour minimum service life.

#### 3.6.14.4. FIRE HAZARDOUS MATERIAL.

Material which, when exposed to heat or flames, releases gas or other substance with extreme toxic potency shall not be used in the construction of the module.

### 3.6.15. PURGE AIR SYSTEM.

The purge air system shall be labeled to avoid accidental blockage of purge air flow.

### 3.6.16. INSTRUMENTATION AND CONTROL.

### 3.6.16.1. INSTRUMENTATION.

The plant shall have, at a minimum, instrumentation to measure the following parameters. Transducers shall be used to measure all pressures. These parameters shall be displayed by the PLC .

Compressor discharge air pressure (psig)
Compressor interstage air pressure (psig) ( if applicable to design)
Dehydrator discharge air pressure (psig)
System air pressure (psig)
Seawater inlet temperature (°F)
Seawater outlet temperature (°F)
Compressor discharge air temperature (°F)
Lubrication medium temperature (°F) at intlet and out let to cooler (if applicable to design)
Lubrication medium pressure (psig) (if applicable to design)
Total run time (hours)
Filter Differential Pressure (psid)

### 3.6.16.2. CONTROLS.

Controllers shall be constructed for continuous duty and general-purpose service. All control enclosures shall be watertight. Controllers shall be designed to function in an ambient temperature of 122 degrees Fahrenheit. Overload protection shall be provided for the motor during starting and running of the compressor. The motor controller shall provide low voltage release (LVR) so that upon reduction or failure of voltage, an interruption of power to the main circuit is caused, but does not prevent the reestablishment of the main circuit or return of voltage. Shock qualified electromechanical relays or equivalent shall be used

#### 3.6.16.2.1. CONTROLLER ASSEMBLY

All controller assemblies should contain the necessary components needed to provide the functions cited in sections 3.6.16.1 This includes, but is not limited to, all power supplies, wiring, terminal blocks, transceivers, signal conditioners, pushbuttons/switches, relays, and fuses.

The controller assembly must have a Local/Remote switch mounted on the outside of the enclosure. The assembly must also have a Battle Override switch mounted internal to the enclosure.

A unique part number shall be assigned to the controller assembly. Part numbers for all parts used within that assembly will also be provided. The assembly will be able to be ordered from the vendor using the part number.

All wiring will be made using 18 AWG wire.

All controllers should be of the programmable logic controller (PLC) type, Allen-Bradley or equivalent.

The PLC components should include a chassis, a PLC processor, a backplane power supply, all necessary input/output (i/o) modules, and all associated wiring harnesses.

The PLC processor must have enough memory to perform the tasks cited in sections 3.6.16.1. In addition, the PLC processor must have two communication ports. One port must be configured to communicate via an Ethernet network to a remote controlling station. The second port must be configured to connect to a local operation panel. The PLC processor must also have an EEPROM for storing code and set points when power is removed from it.

The PLC system will be designed in such a way as to not hardwire input/output modules to terminal blocks (i.e. use of wiring harnesses/swing arms).

All spare i/o channels will be terminated to terminal blocks.

All discrete outputs and 4 to 20 mA inputs/outputs will be fuse protected.

All code that the vendor creates to perform the required functions will be done in ladder logic. The programming environment must be Windows 95, Windows 98, or Windows NT compatible. All source code created by the vendor will be delivered to NSWCCD-SSES in CD-ROM format and hard copy format. In addition, a legal copy of any software used for coding and compiling must be included as a deliverable from the vendor to NSWCCD-SSES. All source code provided by the vendor, once accepted by NSWCCD-SSES as being functional, becomes the sole property of NSWCCD-SSES and the U.S. navy.

A local operating panel must be provided for local operations. This panel will be directly connected to the PLC and will be used when the assembly Local/remote switch is in the Local position. The panel may be of any type (i.e. touch screen, membrane pushbutton, etc.) and is at the discretion of the vendor.

All information which is available for display/control on the local operating panel must be available for use at the communication port designated for use with a remote operating system.

Permanent internal wiring in the controller shall be copper wire or bus bar. The minimum wire size shall be AWG 16, except that AWG 22 may be used for all connections to the programmable logic controllers. Wiring shall be clearly identified with wire numbers. External conductors entering a controller shall be made to terminal boards accessible from the front of the enclosure. Electrical cable shall be low smoke type. Cabling and electrical components in the

controller shall be protected against transients from all sources. The profile of the transients to be protected against shall include a maximum voltage peak seven times normal line voltage having a duration of 5 microseconds. Electrical connectors shall be watertight. Each controller shall include a connection diagram, a schematic diagram, a description of operation, and a table of overloads heaters, coils, and reactors (if used). The information shall be protected by transparent plastic and secured inside of the enclosure.

**3.6.16.2.2. MODES OF OPERATION.**

**3.6.16.2.2.1. AUTOMATIC MODE.**

The plant shall have an automatic mode where the unit starts automatically in response to a pressure signal from the system pressure-piping header. In the automatic mode of operation, the compressor must automatically load and unload in response to a pressure signal from the system pressure-piping header. The bandwidth between the load and unload pressure settings shall be set at 10 psid, but shall be programmable by the operator. If the compressor runs in the unloaded mode for a period of 10 minutes, the compressor shall automatically stop and shall automatically restart in response to system header pressure. There shall be three preset modes of automatic operation : Lead ( load/start at 115 psig ,unload at 125 psig), lag (load/start at 110 psig ,unload at 120 psig)Manual Mode.

The plant shall have a manual start and stop pushbutton or equivalent. The controller shall also have a manual operating mode where the compressor can only be started by a pushbutton or equivalent and will not start by a pressure signal from the system pressure piping header. Once running in the manual mode, the compressor shall not unload but be automatically stopped by a pressure signal from the system pressure-piping header. There shall be three preset modes of manual operation: Lead (load/start at 115 psig, stop at 125 psig) lag (load/start at 110 psig , stop at 120 psig)).

**3.6.16.2.2.2. BATTLE-OVERRIDE.**

There shall also be a means of overriding the electrical safety shut downs of the plant (battle-override), while retaining faults or alarms in memory during override. The system battle-override shall be a switch inside the motor controller to prevent easy access, and shall be properly labeled. The engagement of battle override must be evident when looking at the switch. The override switch will allow the compressor to be run in an emergency situation overriding any PLC controlled safety shut downs (except motor-overload).

**3.6.16.2.3. SAFETY DEVICES.**

Alarms and shut down protection shall be sufficient to protect the compressor from cascading failures. (failsafe protection). Shutdown protection shall protect the compressor under the following situations (at a minimum):

Low lubricating medium pressure (if applicable)
High temperature of lubricating medium (if applicable)
High Compressor Air discharge temperature
High Discharge air pressure

**3.6.16.3. REMOTE DEVICE CIRCUITS.**

Control circuit leads from controllers to remote devices shall be protected against damage from short circuits. Leads wired in series with current limiting parts, such as coils and resistors, which are located within the enclosure will be considered to be adequately protected. Leads not protected by current limiting parts with in the enclosure shall be fused.

### 3.6.16.4. DEW POINT SAMPLE CONNECTION.

The Plant shall have a dew point sample connection to sample the effluent air. This sample connection shall be a self-sealing quick disconnect with a plug. The quick disconnect fitting shall be SNAP TITE P/N SVEAC4-4-57, ¼"MS-33657, 37degree flare, SS with EPR seals, or equivalent. The sample port shall be plugged or capped to protect from contamination and the plug or cap shall be fastened to the unit with a lanyard to ensure against loss.

### 3.6.16.5. GAUGES.

Pressure gauges shall conform to MIL-I-18997. Gauge piping shall not use flare fittings or pipe threads. In addition all gauges will have a test valve in accordance with MIL-V-24578.

### 3.6.17. SAFETY.

Devices requiring attention during maintenance or repair shall be located to preclude potential danger to the operator due to high pressure.

### 3.6.18. HUMAN ENGINEERING.

The plant shall be constructed in accordance with MIL-STD-1472 to preclude or minimize the possibility of failure through improper operation or excessive and complicated maintenance procedures.

### 3.6.19. INSULATION.

Insulation shall be removable and reusable in areas requiring routine scheduled maintenance and repair.

### 3.6.20. RESILIENT MOUNTS.

The compressor shall be resiliently mounted.

## 3.7. MARKING.

### 3.7.1. IDENTIFICATION AND INFORMATION PLATES.

Identification and information plates shall be in accordance with ASTM F992 Type I, II, III, or IV and shall be constructed for shipboard service. Plates shall be made of metallic material such as brass, nickel-copper alloy, corrosion-resistant steel, or anodized aluminum. Plates shall be located where readily visible, and attached to a part of machinery or equipment that will not ordinarily be renewed during its normal service life. Plates shall be permanently attached with corrosion-resistant fasteners which shall not penetrate the frame or the end brackets.

### 3.7.1.1. PLANT IDENTIFICATION PLATE.

A plant identification plate shall be provided and shall contain the following information,

Manufacturer's name and identification number (CAGE).

Manufacturer's model number and serial number.

The number of this specification.

Date of manufacture.

Characteristics:

Plant Classification and maximum rated outlet flow (SCFM)

Discharge Air Pressure.

Dewpoint of effluent air.

Any other pertinent characteristics.

Contract or order number.

National stock number. Space for number shall be provided even though number may not be assigned.

Section for inspector's stamp.

The motor nameplate shall contain the following, etched on 316sstl 0.030 thick, fill with black enamel an polish. Lettering to be .12 high.:

1. Manufacturer's name and serial number
2. Horsepower output
3. Time rating
4. Temperature rise
5. Rpm at rated load
6. Frequency
7. Number of phases
8. Voltage
9. Rated load amperes
10. Rotation

### 3.7.1.2. PIPING CONNECTION IDENTIFICATION PLATES.

All external connections (seawater, freshwater) and all drain lines (seawater, freshwater, oil, etc) shall be labeled , etched on 316 sstl, 0.030 thick, lettering to be .12 high.

### 3.7.1.3. OPERATION AND SAFETY INSTRUCTION SHEET.

An operation and safety instruction sheet shall be provided and shall give the operator clear, concise, step-by-step procedures for start up, operation and shut down of the plant. The instruction plate shall also include:

Schematic flow diagram with the parts identified therein.

Safety precautions required for safe operation and maintenance.

Applicable NAVSEA technical manual number.

### 3.8. WORKMANSHIP.

The plant shall be constructed, assembled, and finished to ensure quality equipment and neat appearance that is free from imperfections that will affect durability, operability, serviceability, and safety. Components shall be able to withstand pressure and temperature requirements without galling of mating parts and without leaking, deforming or warping. Metal portions of units shall be free from fins, burrs, or sharp edges. Welding shall be clean. Painted surfaces shall be clean with no chips or blisters. Failure to meet these requirements shall be cause for rejection.

### 3.9. DRAWINGS.

When specified in the contract or order, drawings shall be prepared (see 6.4.1).

### 3.10. PROVISIONING.

Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

### 3.11. TECHNICAL MANUALS.

Technical Manuals shall be prepared and delivered as contract or order (see 6.4.2).

### 3.12. SPARE PARTS LIST.

~~A List of spare parts needed for maintaining the LPAP for a period of one year shall be provided.~~
A list of parts for all scheduled repair or maintenance cycles shall be provided.

## 4. VERIFICATION.

### 4.1. QUALITY ASSURANCE.

#### 4.1.1. GENERAL PROVISIONS FOR INSPECTION.

Inspection as used herein shall be understood to mean the examination and testing, as applicable, of materials, fabricated components, the manufacturing processes, the completed assemblies and compressors thereof, to determine and ensure conformance to the specifications set forth in the contract or purchase order.

#### 4.1.1.1. RESPONSIBILITY FOR INSPECTION.

Unless otherwise specified in the contract or purchase order, the contractor shall be responsible for the performance of all inspection requirements (examinations and tests) specified herein. The inspections shall be performed in accordance with a systematic program complying with ANSI/ISO/ASQC Q9002 or higher. The contractor may use their own or any other facilities, including available Government laboratories, suitable for the performance of the tests and inspection requirements specified herein unless objected to by the Government. The contractor shall maintain the plant throughout all tests, which includes providing repair parts and consumables, as required. The Government reserves the right to perform any of the inspections set forth in this specification where such inspections are deemed necessary to ensure supplies and services conform to the prescribed requirements.

#### 4.1.1.2. RESPONSIBILITY FOR COMPLIANCE.

All items shall meet all requirements of section 3. The inspection set forth in this specification shall become part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract or purchase order. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of know defective material, either indicated or actual, nor does it commit the Government to accept defective material.

#### 4.1.2. INSPECTION SYSTEM.

The contractor shall have an existing inspection or Quality system in accordance with ANSI/ISO/ASQC Q9002

#### 4.1.3. CLASSIFICATION OF INSPECTION/TESTS.

The testing requirements specified herein are classified as follows:

(a) First Article Testing

(b) Quality Conformance Inspection

**4.1.3.1. FIRST ARTICLE INSPECTION AND TESTING.**

First Article testing is accomplished to validate the vendor's conformance to this specification, and for qualification of new compressor designs. The first article test shall be conducted using two different units (unit #1 and unit #2) . The units tested shall be standard production configuration. Invitations for bids should provide that the Government reserves the right to waive the requirement for first article testing to those bidders offering a product which has been previously acquired or tested by the Government, and deemed to meet the requirements outlined in the first article test.

**4.1.3.1.1.**

The first article test on Unit #1 shall consist of the following:

(a) Visual and Dimensional Examination
(b) Safety
(c) Quality Conformance Inspection
(d) Inclined operation
(e) Shock test
(f) Vibration testing
(g) Airborne Noise
(h) Structureborne Vibration
(i) EMI testing
(j) Motor Qualification Testing
(k) First article performance

**4.1.3.1.2.**

The first article test on Unit #2 shall consist of the following:

(a) Visual and Dimensional Examination
(b) Safety
(c) Quality Conformance Inspection
(d) Shipboard Endurance Test

**4.1.3.1.3. PROCEDURES AND REPORTING.**

**4.1.3.1.3.1. TEST PROCEDURES.**

Test procedures for each element of the first article testing shall be submitted to the contracting officer for approval prior to accomplishment of tests.

**4.1.3.1.3.2. FAILURE/MALFUNCTION REPORTS.**

The contractor shall report all failures, malfunctions or problems occurring during any first article test or examination. Based upon information provided, the government will decide how to proceed. Failures during tests will require, at the government's option, a retest by the government at the contractor's expense.

**4.1.3.1.3.3. FIRST ARTICLE TEST REPORT.**

A report detailing results of all first article testing shall be submitted to the contracting officer for basis of final approval of the plant.

### 4.1.3.2. QUALITY CONFORMANCE INSPECTION.

Each production unit compressor shall be subjected to the following tests:

(a) Hydrostatic (see )
(b) Welding Inspection
(c) Production Unit Performance (see 6.6)
(d) Airborne Noise (see 6.11.5)
(e) Structure borne vibration (see 6.11.6)

## 4.2. TESTS AND EXAMINATIONS.

Except for the Shipboard Endurance Test ( See 4.2.6.1) the contractor is responsible for all first article tests in Para 4.1.3.1.1 and 4.1.3.1.2

### 4.2.1. VISUAL AND DIMENSIONAL INSPECTION.

Each plant shall be examined to determine conformance to this specification. Equipment shall be surface examined, including visual examination for defects, workmanship, and dimensions. Noncompliance with any specified requirements or presence of one or more defects preventing or lessening maximum efficiency shall be cause for rejection.

### 4.2.1.1. WELDING INSPECTION:

All welding shall be inspected per Navsea Publication S9074-AR-GIB-010/278

### 4.2.2. SAFETY.

### 4.2.2.1. SAFETY OF PERSONNEL.

The unit shall meet the safety requirements as specified in 3.3.3

### 4.2.2.2. SAFETY OF EQUIPMENT.

A demonstration shall be conducted to verify that all safety devices function properly and will effectively protect the unit from damage in the event of:

(a) High discharge air temperatures.
(b) High discharge air pressure.
(c) Low voltage.
(d) High lubrication medium temperatures.
(e) Low lubrication medium pressure

### 4.2.3. HYDROSTATIC

The following parts of each compressor shall be hydrostatically tested for 30 minutes in accordance with the following:

(a) Heat exchangers, 1 ½ times the maximum designed working pressure on the water side and 1 ½ times the maximum design working pressure on the air side.
(b) Piping shall be tested to 1 ½ times the maximum designed working pressure.
(c) Flexible Hoses: All flexible hoses must be pressure tested at 1 ½ times the maximum designed working pressure. All flexible hoses must be tagged with test pressure and test date.

**4.2.4. INCLINED OPERATION.**

The first article test unit shall be tested for compliance with required inclined operation 3.2.7 The plant shall be operated at rated load for not less than 30 minutes with the base tilted 15 degrees in each of the four cardinal positions; right, left, front; rear. During the progress of these tests, there shall be no excessive heating of any parts

**4.2.5. FIRST ARTICLE PERFORMANCE.**

A first article performance test shall be conducted at the contractors facility or a facility approved by the contracting officer. The test shall be witnessed by a government representative. The compressor shall be run for a minimum of 300 hours total including the following:

(a) 100 hours of operation at 122°F, 50% RH, and 100°F seawater supply.
(b) 100 hours of operation at 122°F, 50% RH, and 50°F seawater supply.
(c) 100 hours of cyclic operation (10 minutes running, and 20 minutes not running).

**4.2.5.1.**

The following data points shall be recorded at a minimum.

(a) Compressor serial number
(b) Relative humidity
(c) Intake temperature (close to inlet air filter)
(d) Ambient barometric pressure
(e) Air discharge pressure from each stage of compression. (if applicable)
(f) Compressor discharge air temperature.
(g) Compressor discharge air pressure.
(h) Compressor discharge capacity.
(i) Final discharge air pressure.
(j) Final discharge capacity.
(k) Final discharge air dewpoint.
(l) Cooling water inlet temperature.
(m) Cooling water outlet temperature.
(n) Cooling water pressure.
(o) Cooling water flow.
(p) Revolutions per minute of driving unit and of compressor.
(q) Lubricating medium pressure.
(r) Lubricating medium temperature.
(s) Supply voltage, amperage, and frequency.
(t) Power input to motor.
(u) Verify all cycling and switching actions required for normal compressor operation.
(v) Verify all failsafe/shutdown features are functional

**4.2.5.1.1. CAPACITY TEST**

ADD Here **Capacity (unit #1 and #2)**. Capacity is the direct measurement of the flow from the LPAC, which would be delivered to the air system. Charging capacity measurements are not acceptable. Each plant discharge shall be tested for capacity by the following test:

ASME method. The actual measured capacity of the compressor may be determined by the ASME flow nozzle method as outlined in the American Society of Mechanical Engineer's Power Test Code 9. Navy standard conditions for capacity measurements are 68 degrees Fahrenheit, 14.7 psia, and 36% relative humidity.

Alternate method. An alternate method of direct measurement of the flow from the air compressor can be used if it has been submitted and approved by CDNSWC Code 9214.

**4.2.5.2. FIRST ARTICLE PERFORMACE TEST ACCEPTANCE CRITERIA:**

The plant will pass the First Article Performance Test if no parts show evidence of imminent failure, if the performance of the plant has remained steady and unchanged as evidenced by normal profiles of recorded operating temperatures and pressures throughout the test duration, if all measured parameters are in accordance with the requirements specified herein, and if pressure and temperature controls and devices are functioning properly.

**4.2.6. SHIPBOARD ENDURANCE TEST.**

An endurance test on compressor Unit #2 shall be conducted shipboard. The compressor shall be run a minimum of 2000 hours of shipboard duty. The test plan will be developed by NSWCCD-SSES code 9214. The contractor shall provide personnel to visit the ship for initial lightoff at contractors expense, as well as if problems with the compressor arise.

**4.2.6.1. POST-ENDURANCE TEST TEARDOWN.**

Upon completion of the 2000 hour shipboard test, the plant wear components shall be visually inspected and measured. The dimensions shall be compared with the dimensions prior to the test, if available, or with the nominal dimensions on the applicable drawings. Based on the parts comparison an attempt will be made to predict the expected minimum hours between overhauls of the compressor. A test report shall be prepared and provided to contracting activity.

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**4.2.7. SHOCK TEST.**

One plant of each design shall be shock tested in accordance with MIL-S-901 for class II equipment. When the shock tests are conducted using a medium weight shock machine, six blows shall be applied as described in MIL-S-901D. The mounting platform shall be in a horizontal position and the blows shall be applied under the approximate center of gravity of the assembled plant. The equipment shall be tested fully loaded and at standstill on alternate blows. In addition to the six blows required above, three additional blows shall be applied at the approximate center of gravity with the base of the plant inclined at 15 degrees from the horizontal. The blows of the inclined test shall correspond to groups I, II, and III of MIL-S-901D. The plant shall be running during all inclined blows. A shock test plan shall be submitted by the contractor and approved by NSWCCD. A shock test report shall be submitted by the contractor and approved by NSWCCD The test plan shall include, but not be limited to the following examinations.

**4.2.7.1. POST-SHOCK TEST EXAMINATION.**

**4.2.7.1.1. MOTOR.**

After the shock test performed in accordance with 4.2.7, the motor shall be undergo the follow tests and qualifications.

**4.2.7.1.1.1.**

The motor shall be examined in accordance with IEEE 112 (see 3.6.10).

#### 4.2.7.1.2. COMPRESSOR.

Examination of the compressor shall be conducted as follows:

(a) Examine the unit carefully and note the extent of any external damage.
(b) Turn the compressor over several times by hand to ensure that all working parts are free and ready for starting.
(c) Run the compressor unloaded for a short time and note any mechanical peculiarities. Demonstrate controller will control the compressor.
(d) Build up the load gradually and carefully check any undue noises or excessive vibration or other nonconformity.
(e) Conduct performance tests IAW 4.2.12 Steps a-o, u and v)
(f) Secure the compressor and disassemble for complete examination.
(g) Observe and record all effects of shock test on the various compressor components.

#### 4.2.7.1.3. DEHYDRATOR.

The plant shall be operated at ambient operating parameters for 4 hours. The effluent air dewpoint shall recover to maximum allowable levels specified in Table 1 or dryer within 1 hour after start up.

### 4.2.7.2. SHOCK TEST ACCEPTANCE CRITERIA.

#### 4.2.7.2.1. MOTOR.

The motor will be considered to have passed the shock test if it conforms to MIL-M-17060F section on motor acceptance after shock testing.

#### 4.2.7.2.2. COMPRESSOR.

The compressor will be considered to have passed the shock test unless any of the following applies Acceptance Criteria shall be provided in the Shock TestPlan:

(a) Breakage of any parts, including accessories and mounting bolts.
(b) Detachment of any part or object from the unit.
(c) Compressor requires attention or adjustment or replacement of parts to enable it to perform its principal function during and after each blow of the test.

Equipment which has been subjected to shock tests and has failed will not be accepted, either in whole or in part, until the causes of such failure have been corrected by the contractor and the complete equipment has been re-tested. However, failure of the compressor only shall not cause rejection of an otherwise acceptable motor nor shall failure of a motor only cause rejection of an otherwise acceptable compressor.

### 4.2.8. VIBRATION EXTERNALLY EXCITED.

First Article unit shall meet the type I (environmental) vibration test and Type II (internally excited) requirements of MIL-STD-167/1. Vibration testing shall be conducted up to a frequency level of 25 hertz (Hz). A Vibration test plan shall be submitted by the contractor and

approved by NSWCCD. A Vibration test report shall be submitted by the contractor and approved by NSWCCD.

### 4.2.9. AIRBORNE NOISE.

First article unit shall be noise tested in accordance with MIL-STD-740/1, equipment grade D, (see 6.2). A airborne test plan shall be submitted by the contractor and approved by NSWCCD. A airborne test report shall be submitted by the contractor and approved by NSWCCD.

### 4.2.10. STRUCTUREBORNE VIBRATION.

When requested (Combat ships only, see 6.2.1) the compressor shall meet the structure borne vibration requirements shown in Table II and/or the specific Ship Class requirements given (see 6.2). The vibration shall be measured at the mounting feet in accordance with MIL-STD-740/2. A Stucturborne vibration test plan shall be submitted by the contractor and approved by NSWCCD.

**Table II - Structureborne Vibration Levels.**

| Frequency (hz) | Up to 10 | 10 to 40 | 40 to 160 | Above 160 |
|---|---|---|---|---|
| Maximum sound level (dB relative to $10^{-3}$ $cm/sec^2$, 1/3 octave band levels) | 80 | 108 | 95 to 110 in an increasing straight line. | 110 |

### 4.2.11. EMI / EMC / TESTING.

The First Article unit shall meet the requirements of MIL-STD 461E, susceptibility test CE101, CE102, CS 101, CS 114, CS115, CS116, RE 101, RE102, RS101 and RS 103. A EMI test plan shall be submitted by the contractor and approved by NSWCCD. A EMI test report shall be submitted by the contractor and approved by NSWCCD.

### 4.2.12. PRODUCTION UNIT PERFORMANCE TEST.

Each production unit shall be subjected to a test of at least 40 hours duration to demonstrate that capacity, pressures, temperatures and power requirements specified in 3.2 are met. Operation shall be at the ambient conditions present at the contractor's facility. For these tests, all measured parameters shall be recorded at the start and finish of the run and at regular intervals, not exceeding 1 hour throughout the run. A report shall be prepared and provided to the contracting activity. The following minimum information shall be recorded for the performance tests:

(a) Compressor serial number
(b) Relative humidity
(c) Intake temperature (close to inlet air filter)
(d) Ambient barometric pressure
(e) Air discharge pressure from each stage of compression. (if applicable)

(f) Compressor discharge air temperature.
(g) Compressor discharge air pressure.
(h) Compressor discharge air flow.
(i) Final discharge air pressure.
(j) Final discharge air flow.
(k) Final discharge air dewpoint.
(l) Cooling water inlet temperature.
(m) Cooling water outlet temperature.
(n) Cooling water pressure.
(o) Cooling water flow.
(p) Revolutions per minute of driving unit and of compressor.
(q) Lubricating medium pressure.
(r) Lubricating medium temperature.
(s) Supply voltage, amperage, and frequency.
(t) Power input to motor.
(u) Verify all cycling and switching actions required for normal compressor operation.
(v) Verify all failsafe/shutdown features are functional
(w) Quality Conformance Inspection (see 4.1.3.2)

**4.2.12.1. PRODUCTION UNIT PERFORMANCE TEST ACCEPTANCE CRITERIA.**

Production units shall considered in compliance with this specification if the following conditions apply. Any operational malfunction of the compressor assembly shall be cause for rejection.

(a) No parts show evidence of imminent failure.
(b) The performance of the plant has remained steady and unchanged as evidenced by normal profiles of recorded operating temperatures and pressures throughout the test duration.
(c) All measured parameters are in accordance with the requirements specified herein
(d) Pressure and temperature controls and devices are functioning properly.
(e) The lubricating system is free of particulate matter.
(f) All failsafe features are operational.

**4.2.13. MOTOR QUALIFICATION TESTING.**

**4.2.13.1.**

Complete motor tests per IEEE 112 which include:

1. Measurement of winding resistance.
2. No-load readings of current and speed at normal voltage and frequency.
3. High-potential test.
4. Full-load temperature rise.
5. Efficiency.

6. Power factor.
7. Starting, pull-up and breakdown torque.
8. Rated load slip

## 5. PACKAGING

All liquid shall be drained from the plant prior to packaging.

For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department of Defense or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

## 6. NOTES.

### 6.1. INTENDED USE.

Air compressors covered by this specification are intended for general shipboard use on US Navy surface ships.

### 6.2. STUCTUREBORNE NOSIE TESTING: TESTING OF STRUCTURBORNE NOISE IS NOT REQUIRED FOR THIS CONTRACT.

### 6.3. PACKAGING RESTRICTIONS

### 6.3.1. CUSHIONING AND WRAPING MATERIAL :

The use of excelsior, newspaper, shredded paper (all types) and similar hydroscopic or non-neutral materials, and all types of loose fill material for applications such as cushioning , fill stuffing and dunnage is prohibited. Material selected for cushioning and wrapping shall be resistant to fire.

### 6.3.2. ASBESTOS:

Asbestos or materials and items containing asbestos shall not be used in packaging.

### 6.4. TECHNICAL DATA.

The contractor shall provide technical data in accordance with the data ordering documents included in the contract or order and as specified in 3.4.1 through 3.4.2.5. It is requested that all technical data be forwarded to the Life Cycle Manager for Compressed Air Systems, NSWCCD-SSES Code 9214.

### 6.4.1. DRAWINGS AND CDS, ENGINEERING AND ASSOCIATED LISTS.

All engineering drawings prepared for the manufacturing, production, installation, operation, maintenance and repair of the compressor on contract or purchase order shall be subject to the quality assurance provisions in Section 4. The drawings and the technical and engineering data thereon will be reviewed by the procuring activity. Drawings and associated lists, indexes CDs and microfilm, specified to be transmitted to the Government, shall be subject to the quality assurance provision of the applicable specification with respect to content, format and preparation. Product drawings and associated lists shall be identified by the manufacturer's

drawing numbers and shall be in accordance with ASME Y14.100M. Full size reproducible drawings shall be inked on cloth, CDs or polyester film. Full size prints of drawings may be diazo, blueprints, or electrostatic prints. Digital representation of drawings shall be in raster format or vector format as follows:

The drawings and CDs required by the Government shall delineate, fully and clearly, the design, construction and performance capability of the compressor and to permit naval personnel, in conjunction with technical manuals, to install, operate, maintain, and repair the compressor, its equipment, and accessories. The drawings and/or CDs provided shall contain appropriate elements of the following types of drawings, as described in ASME Y14.100M: assembly drawings; detailed assembly drawings; installation assembly drawings; exploded assembly drawings; interface control drawings; installation drawings; diagrammatic drawings; connection or wiring diagrams; piping diagrams and drawings for maintenance and repair. The complete set of drawings and/or CDs provided shall include the following:

a) Diagram and certification data.
b) Assembly drawings.
c) Electrical circuits arrangements.
d) Details of all parts and assemblies.
e) Test, calibration, manufacturing, welding, brazing. Painting and any other procedure listed on any supplied drawing.
f) Maintenance and repair.

Equipment drawings and CDs shall include parts lists, lists of materials and material specifications. Certification data drawings shall include diagrams and drawing lists. The number of drawings sheets shall be kept to a practical minimum and shall be consistent with the requirements specified herein.

### 6.4.1.1. ASSEMBLY DRAWINGS AND CDS.

Assembly drawings and CDs shall be provided for the compressor. Drawings and CDs shall be sufficiently complete to show compliance with equipment specification requirements. Where necessary to illustrate compliance, details may be included on the assembly drawing and CDs, or provided as separate drawings and CDs. Subassembly drawings and CDs shall be furnished where assembly drawings do not adequately describe and identify subassembly parts and components. The assembly drawings and CDs shall show outline, mounting attachment and connection dimensions including methods and sizes of fastenings and clearances for installation and servicing plus supplementary data necessary to permit installation with contractor's assistance. The drawings and CDs shall illustrate design, construction, operation (or function), identity of parts, and model number. Connections requiring interface with ships installed piping shall be delineated as to size, type and three plane dimensional locations indicated with a tolerance no greater than plus or minus ¼ inch. Performance data and curves shall be included with design conditions.

### 6.4.1.2. CERTIFICATION DATA DRAWINGS AND CDS.

Certification data drawing(s) shall be provided. These drawings shall be certification by the contractors that the compressor and its components and accessories, comply fully with this specification, as invoked in the contract or purchase order. Certification data drawings shall

include a reference drawing list of all the compressor assemblies, components, and auxiliary components being furnished on the contract or purchase order. Diagrams shall also be provided. Diagrams shall include electrical control diagram and electronic diagram as applicable and electrical wiring diagram, Diagrams shall show by symbolic representation line sizes, electrical interconnections, components, accessories, control and associated instruments, operating sequence and connections required by others for operation. Symbols used for equipment shall be given a piece number and identified in the list of materials with the following information:

a) Piece number
b) Quantity required
c) Descriptive name
d) Manufacturer's name
e) Manufacturer's model or identifying number
f) Characteristics

The characteristics shall include ordering information necessary to specifically qualify or supplement data described in reference drawing or manufacturer's model and part number. A separate table shall be used for the various components where necessary.

### 6.4.1.3. DETAIL DRAWINGS AND CDS.

Detail drawings shall be furnished of parts and subassemblies necessary for evaluation of the compressor and parts. Drawings for the compressor shall show sufficient detail for maintenance and repair/overhaul of components. Drawings are not required to be detailed enough for manufacture of components. Subassemblies whose parts cannot be procured or serviced individually should be shown as a single part. Multi-detailed drawings are preferred, but mono-detail drawings may be used. Drawings are not required for those parts, which are in common commercial use and can be referenced to a commercial standard. The contractor's procurement specification either as a drawing or a part description shall be provided.

### 6.4.1.4. ELECTRICAL COMPONENT AND ELECTRONIC DRAWINGS AND CDS.

In addition to drawing requirements specified herein, the content and format of electrical component and electronic drawings shall conform to the requirements of the applicable component specification.

### 6.4.2. TECHNICAL MANUALS.

### 6.4.2.1. TECHNICAL MANUAL DRAWINGS.

Each manual shall contain line drawings of the control system to show clearly the arrangement of its components. A section shall be provided at the back of the manual containing reduced size copies of drawings including diagrams and assembly drawings of the compressor, electrical schematics, and point to point and connection diagrams. Drawings may be referenced in order to amplify the text. In addition, those portions of the text which describe operation, maintenance procedures, assembly, disassembly, alignment, control adjustment, etc., shall be sufficiently detailed to permit accomplishment of procedures or actions without repeated reference to drawings in the back of the manual. Exploded view drawings of all compressor components shall be provided.

### 6.4.2.2. DRAWINGS AND CDS FOR MAINTENANCE AND REPAIR.

The drawings for maintenance and repair shall provide all technical data to ship personnel and repair activities for maintenance and repair of the compressor. The drawings for compressor maintenance and repair shall include all technical data to accomplish in conjunction with the use of the written text of the technical manual , but without additional assistance from the manufacturer, the following tasks related to operation, maintenance and repair:

(a) Maintain the compressor at optimum performance for the intended service.
(b) Determine the degree of wear and acceptability for further service of parts and components.
(c) Document onboard repair part provisioning.
(d) List of supplied equipment and acceptable replacement parts.
(e) List of special tools, including a drawing of each special tool which will permit ship's personnel to make the tool in an emergency.

**6.4.2.3. ENGINEERING DRAWINGS AND/OR CDS.**

Detailed engineering drawings shall also be provided in the technical manual. The detailed engineering drawings shall provide parts identification and associated parts lists.

**6.4.2.4. QUANTITATIVE MAINTENANCE DATA.**

Manuals shall provide adequate quantitative maintenance data such as maximum allowable wear, maximum permissible eccentricities and misalignment, required clearances, interference fits, torque values of threaded fasteners.

**6.4.2.5. DETAILED SCHEDULE MAINTENANCE.**

Detailed schedule maintenance procedures for ships force, and depot level of maintenance shall be delineated in the manual.

**6.4.2.6. VALIDATION.**

The contractor shall validate or have validated the technical manual for the plant. The contractor shall provide verifiable evidence of the adequacy of the validation performed. Validation shall be completed and corrections made and revalidated prior to presentation of any part of the manuscript to the Government for verification. Validation shall include, but not be limited to, the following:

(a) Written information, engineering drawings, and art work in the manual shall be compared to the related physical equipment to assure that they actually delineate the equipment accurately.
(b) A demonstration by actual performance of instructions and procedures in the manual on the physical equipment shall be accomplished. Items of the following nature need not be performed:

(1) Destruction of material, such as disassembly of electronic components.
(2) Boring, grinding, and other shaping repair procedures.

**6.4.2.7. COPIES PACKED WITH INDIVIDUAL COMPRESSORS.**

One copy of the technical manual shall be packed and delivered with each compressor on a contract or order. In the event the final manual is not available, copies of the preliminary manual shall be provided.

### 6.4.2.8. ELECTRONIC COPIES OF MANUAL.

The contractor shall submit an electronic copy of the technical manual (including drawings) to the Navy upon final approval of the manual.

## 6.5. FINAL ACCEPTANCE/RELEASE FOR PRODUCTION:

The release for production shall be after the completion of:

**First Article Testing IAW 4.2**

## 6.6. TECHNICAL MANUAL

Cognizant NAVSEA activities shall verify the manual(s) required to be supplied under the terms of the contract. Verification shall be based on witnessing a demonstration of the actual performance of instructions and procedures contained within the manual on the physical equipment, using a valid sampling plan as a minimum. Verification is to be performed simultaneously with validation whenever possible.

## 6.7. SPARE PARTS

### 6.7.1. ENDURANCE TEST SPARE PARTS

The contractor shall provide a spare parts kit with the First Article Test Units. The spare parts shall include all parts needed to do routine maintenance for a period of one year.

### 6.7.2. SPARE PARTS LIST

A Recommended List of spare parts needed for maintaining the LPAP for a period of one year shall be provided. A list of parts for all scheduled repair or maintenance cycles shall be provided

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## 6.8. WARRANTY.

The offered shall include the terms of the standard one year commercial warranty.